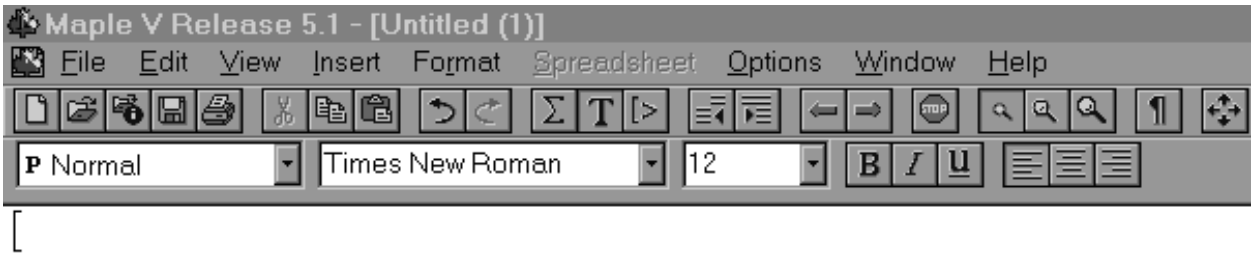
C2M0

Introduction to Maple V

Open Maple and obtain a blank worksheet. We are going to begin by establishing a format for each Maple assignment that is to be handed in. Do not type the "<" or ">" shown to identify your entries. And <Enter> means the "Enter" key. As you begin, the worksheet is in "math mode", so 'click' on the **T** to switch into "text mode".



Type <C2M1> <Enter> and then highlight C2M1 and click on the middle of the three boxes to the right of **B** *I* u so as to center C2M1. The left of these three buttons left-justifies text and the right one right-justifies it. Now,
<down arrow>, then type your name and section as shown.
<Midn Your Name> <Enter>
<Section> <Your section> <Enter>
Having completed this, highlight the three lines and then click on **B** to boldface everything. This is the format you should use for all Maple assignments to be handed in. For example, you should see something like

C2M1

Midn John Doe
Section 1234

You may eliminate the brackets on the left by the function key <F9>. To return to math mode, click on the [>. If we wanted to type a math formula while in text mode we would click on Σ. The class of 2001 has Release 4 of Maple V, and the classes of 2002 and 2003 have Release 5 or 5.1 . There are some differences between the releases and we will address them as we proceed. Later in this section we will discuss *palettes* which allow you to select commands from a menu and avoid using Maple syntax. It is the contention of the author of these notes that learning some Maple syntax is beneficial to the student, so even though you may accomplish the same things by clicking on a symbol, we will show you the syntax that would otherwise be hidden.

There are several packages of programs in Maple that we will find useful. For many calculus operations we will need "student". In math mode, lines in Maple end with a semicolon or colon. If you put a colon after the line then the display of the output is suppressed. Please type the command lines below in a new worksheet exactly as you see them and note the output. This work is for your benefit and is not intended to be handed in.

```
> with(student):
> A:=Int(x^2,x);
> value(A);
> B:=int(x^2,x);
> C=Int(x^2,x=2..5);
> value(C);
```

In the first line, the name "A" is being assigned to the unevaluated integral, $\int x^2\,dx$. Then we find the value of "A". By using the lowercase "i" we assign the name "B" to the value of the integral, rather than the inert expression that is not yet evaluated. By eliminating the colon, we have established an equation rather than assigning a name "C" to the integral. Think of it this way. The integral is being assigned to a piece of memory named "A", another piece of memory is assigned the value of that integral and is named "B", while an equation involving "C" and an unevaluated definite integral is established. Evaluating "C" is

meaningless because there is no piece of memory with that name. Go back, insert the colon as was done with "A" and hit <Enter> and then another <Enter>. The exact value of the integral, 39, should appear. Be very careful of these subtleties, because Maple cannot read your mind. What happens when you put a semicolon after ' `with(student)`' instead of the colon?

In that same worksheet enter these command lines and observe the output.

```
> value(Pi^2/6);
> evalf(Pi^2/6);
> S100:=Sum(1/k^2,k=1..100);
> value(S100);
> evalf(S100);
```

The `evalf` command converts an exact numerical expression to a floating point number.

It is very important to know how to define a function, how to define an expression, and the difference between them. To define the function $f(x) = 4 - 2x - x^2$ please enter:

```
f:=x->4-2*x-x^2;
```

And then evaluate f at $x = 4/3$ by:

```
f(4/3);
```

Now define an expression *expr* by:

```
expr:=4-2*x-x^2;
```

In order to evaluate an expression at a value, we must substitute into the expression. Try:

```
subs(x=4/3,expr);
```

And when we try to use an expression as if it were a function, we get garbage. Try:

```
garbage:=expr(4/3);
```

It will be very useful later to be able to make a function out of an expression. The syntax for this is puzzling. Entering these commands should produce these results:

```
> P:=x^2+cos(x);
```

$$P := x^2 + \cos(x)$$

```
> G:=unapply(P,x);
```

$$G := x \to x^2 + \cos(x)$$

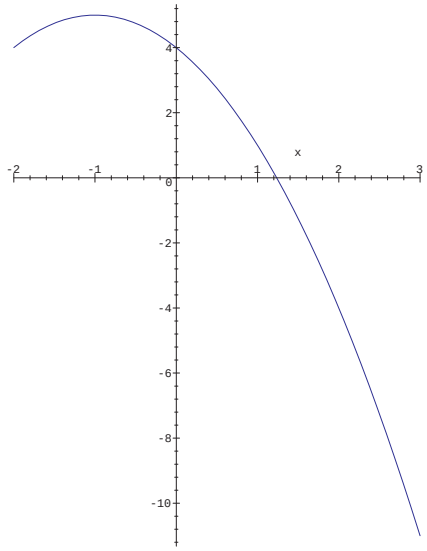
```
> G(Pi);
```

$$\pi^2 - 1$$

We see that G is a function and that $G(x) = P$.

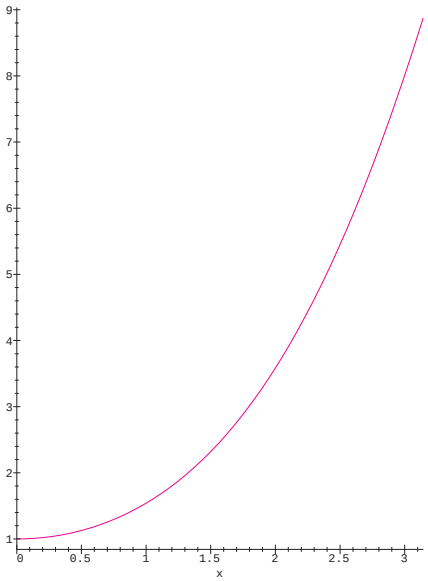
Maple graphics are versatile and easy to use. Above we defined $f(x) = x^2 + \cos(x)$ in our worksheet. We can get a quick plot of f on $[-2, 3]$ by:

```
> plot(f(x),x=-2..3,color=blue);
```



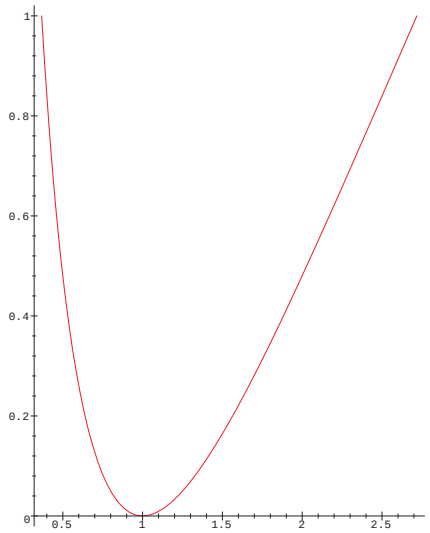
Note how we used $f(x)$ which is an expression, not just f, in this plot. To plot the function G from above we could use P or $G(x)$ and obtain identical results.

```
> plot(P,x=0..Pi,color=magenta);
```

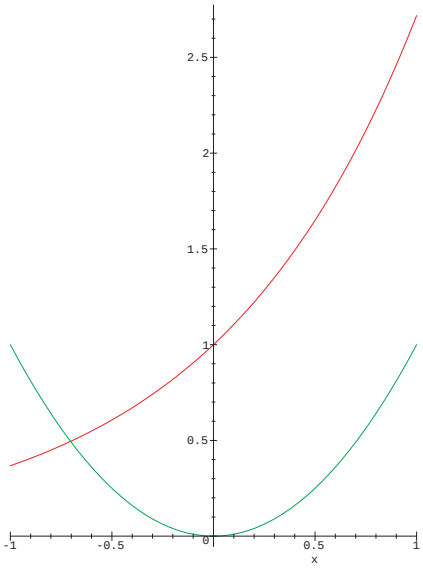


When you wish to plot two functions with the same domain it can be done very easily. However, it is very easy to confuse the syntax with parametric plotting. We will do an example of each so that you will know where to be careful. The placement of the righthand square bracket determines which format you have. In two-dimensional plotting, when you list two expressions and a range inside the square brackets the first function controls the value on the x-axis and the second function controls the value on the y-axis. This is parametric plotting. To save space the output follows on the left.

```
> plot([exp(x),x^2,x=-1..1]);
```



Parametric Plotting



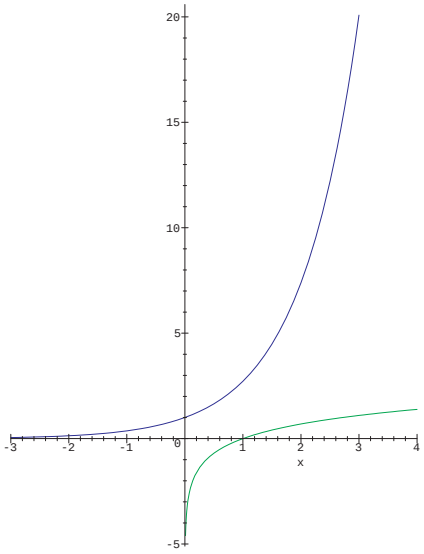
Two Functions

When you do not include the domain inside the square brackets you get two different plots on the same coordinate system as you can see above on the right. This was produced by:

```
> plot([exp(x),x^2],x=-1..1);
```

How should you plot two functions on the same coordinate axes which have different domains? The answer is to give each plot a name **using a colon at the end to suppress the output** and then display them together. The command `display` is in the graphics package called `plots`.

```
> with(plots):
> A:=plot(exp(x),x=-3..3):   ← colon!
> B:=plot(ln(x),x=.01..4):   ← colon!
> display(A,B);   ← semicolon!
```



There are two operations that are very basic in calculus, namely differentiation and integration, or anti-differentiation. Expressions in x and t can be differentiated with respect to either variable so we must remember to specify the variable. Using the expression $P = x^2 + \cos(x)$ from above we have

```
> Pprime:=diff(P,x);
```

$$Pprime := 2x - \sin(x)$$

And if we integrate P

```
> Pint:=int(P,x);
```

$$Pint := \frac{x^3}{3} + \sin(x)$$

Now let's do some of the same steps by using a palette. On your command line type

```
A:=
```

There are three palettes and to access them you begin by clicking on "View", then "Palettes". If you need symbols, select that palette, but for now we choose "expressions". You should see

Click on the box with the integral symbol $\boxed{\int a}$. Then click on the box with $\boxed{a^b}$. On your command line the cursor appears where you want x inserted, so you type $< x >$, and then **move to the next entry position by using the 'Tab' key**. Enter $< 2 >$, <Tab>, and then the variable of integration, $< x >$ and <Enter>. At the end of the command line put a semicolon and hit <Enter>. This should produce

```
> A:=int(x^2,x);
```

$$\frac{x^3}{3}$$

Suppose you have a question about some aspect of using Maple and the syntax is confusing you. On the command line simply type

```
<?topic>
```
 <Enter>

and Maple will display what you need to learn about "topic". You can copy from the help page and paste on the command line as needed.